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(71) Applicant: SCANIA CV AKTIEBOLAG [SE/SE]; S-151 87 Södertälje (SE).

(72) Inventor: GRÖNLUND, Mats; Sätra torg 4, III, S-127 38 Skärholmen (SE).

(74) Agent: BYSTRÖM, Ola; Scania CV AB, Patent, S-151 87 Södertälje (SE).

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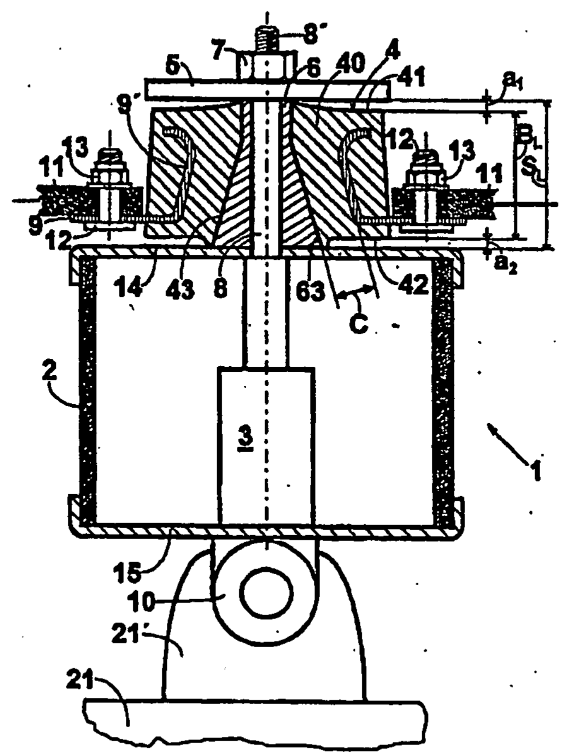
(54) Title: ARRANGEMENT FOR RESILIENT SUSPENSION OF A CAB WITH RESPECT TO A VEHICLE FRAME

(57) Abstract

The invention relates to an arrangement for resilient suspension of a cab with respect to a vehicle frame, and a bushing which forms part of the arrangement. The cab is connected to the vehicle frame by means of a number of spring struts (1) which are anchored in elements (11) fixed to the cab via a bushing (4) which filters out body noise within the frequency range 80-300 Hz with amplitudes of up to 2-3 mm. These types of vibrations are not kept up with by shock absorbers, because of internal friction and hysteresis. The rubber bushing (4) is arranged on a suspporting sleeve (6) which is anchored to the spring strut (1) and which is clamped between two stop surfaces (5, 14). The supporting sleeve (6) has an axial length (S_L) which exceeds the corresponding axial length (B_L) of a rubber element (40). The bushing is dimensioned so that under static load due to the service weight of the cab there is a clear distance (a_1, a_2) between the stop surfaces (5, 14) and the axially directed surfaces (41, 42) of the bushing.



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Arrangement for resilient suspension of a cab with respect to a vehicle frame.

The invention relates to an arrangement for resilient suspension of a cab with respect to a vehicle frame according to the preamble of patent claim 1, and a bushing, which forms part of the arrangement, according to the preamble of patent claim 8.

State of the art.

The suspension of flexibly mounted cabs with respect to the frames of heavy-duty vehicles such as trucks at present involves inter alia a number of spring struts each incorporating a spring and a shock absorber. Each spring strut is often provided, at its upper fastening, with bushings in the form of rubber rings in order to damp vibrations.

These rubber rings have to be sufficiently rigid to cope with being loaded by the cab. This involves either the rubber rings or the shock absorbers being able to filter out objectionable effects within a frequency range of approximately 80-300 Hz depending on hysteresis and internal friction. However, this frequency range often includes disturbing vibrations from the frame, often with amplitudes of less than 2-3 mm, which may thus be propagated to the cab.

SE 94 02 296 refers to a forward cab suspension fastening which is otherwise advantageous but which incorporates a heavy cast bracket for fastening the shock absorber to the cab, which makes disturbing low-amplitude noise even more critical.

SU 14 81 130 refers to a bushing which is designed to reduce the propagation of vibrations, but this bushing also constitutes a spring device (there is no spring strut) and does in fact merely cause a rigidity which increases gradually with increasing load.

A multiplicity of different arrangements for fastenings of spring strut designs with spring and shock absorber are known from vehicle wheel suspensions in which rubber bushings have greater rigidity at larger amplitudes in order to cope with power loads and less rigidity at small amplitudes for vibration damping. Such solutions are referred to, for example, in SE 159 273 and WO 89 05 242.

However, quite different load situations apply to the cab suspension of a heavy vehicle. There

are several excitation sources, since the frame is a large mass which is acted upon by vibrations not only from the drive unit, trailers and superstructures but also from the wheels. It is therefore not possible to transfer solutions directly from the wheel suspension of passenger cars to the cab suspension of heavy-duty vehicles.

Objects of the invention.

The invention has the object of providing a heavy-duty highway vehicle such as a truck with an improved flexible cab suspension, preferably a forward suspension of the type referred to in SE 94 02 296, whereby special and ordinarily occurring low-amplitude vibrations from the vehicle chassis in the frequency range of approximately a few hundred hertz can be filtered out and hence essentially not reach the cab, irrespective of whether the vibration causes the cab to move away from or towards the frame.

A further object is to provide a simple and reliable rubber bushing which can be used in a cab suspension whereby all major loads on the fastening of the spring strut in the cab via the bushing cause the latter to "bottom" and be mainly subjected to compressive load, thereby minimising the risk of the bushing failing by shearing. To this end, the bushing should be made very weak with respect to low-amplitude vibrations in the aforesaid frequency range so that these vibrations can be filtered out effectively and not reach the cab.

Another object is to make it easy to fit a spring strut to the cab which, as a composite unit including a spring fixed in the spring strut and a shock absorber, can be fitted firmly with respect to a purpose-made fitting recess in the lower portion of the cab.

Brief description of the invention.

The arrangement for cab suspension according to the invention is distinguished by what is indicated in the characterising part of patent claim 1, and the bushing which forms part of the arrangement by what is indicated in the characterising part of patent claim 8.

Other features and advantages which distinguish the invention are indicated by the characterising parts of other patent claims and by the following description of an embodiment. The description refers to the attached drawings.

List of drawings.

Figure 1 shows a side view of a spring strut.

Figure 2 shows the force in the rubber bushing as a function of the deflection movement S.

Figure 3 shows an unfitted rubber bushing which is not prestressed by the dead weight of the cab.

Figure 4 shows schematically a vehicle cab suspended with respect to the frame by means of four spring struts.

Description of an embodiment.

Figure 1 shows a spring strut 1 incorporating a shock absorber 3 and a spring 2 which is arranged parallel with the shock absorber. In this case the spring 2 is an air bellows which is arranged concentrically with the shock absorber and which can in a conventional manner (not shown) be filled with and emptied of compressed air in order to adjust the level of the cab. The shock absorber is arranged within the air bellows and is clamped between upper and lower end covers 14,15. The fact that the shock absorber is internally clamped between the end covers of the air bellows without movable penetrations makes it easy to seal the air bellows. The air bellows 2 may be replaced by another type of spring such as a coil spring. The spring 2 and the shock absorber 3 are arranged as a composite unit between the end covers 14,15. This makes it easy to fit the spring strut with respect to the cab and the frame.

A fastening eye 10 is arranged on the lower end cover 15 and can be flexibly anchored to an element fastened to the frame, advantageously a corresponding fastening eye 21' or a pin firmly arranged on the frame 21. It may be advantageous to use an alternative arrangement according to SE 92 03 909.

In the upper part of the spring strut there is a rubber bushing 4 according to the invention incorporating a sleeve-shaped rubber element 40 and an internal rigid supporting sleeve 6 arranged on an at least partly threaded rod-shaped device 8 which protrudes upwards from the upper portion of the spring strut, preferably an axial extension of the piston stem of the shock absorber 3, which only requires a static seal at the penetration through the end cover 14. The supporting sleeve 6 is anchored to the upper end cover 14 of the spring strut by means of a nut 7 which is applied to the rod-shaped device 8 and which presses a stop surface 5, here a loose

washer, against the upper portion of the supporting sleeve 6. The supporting sleeve 6 of the rubber bushing is thus clamped firmly between two stop surfaces, namely the washer 5 and the upper end cover 14 of the spring strut.

The bushing 4 is connected to the cab via a bracket 11 which is fastened to the cab. A fastening element 9 is cast in, along its radial inner portion 9', into the rubber element. The radially outer portion of the fastening element 9 protrudes clear of the rubber element 40 and is provided with holes 16 through which anchoring bolts 12 are arranged. The anchoring bolts may alternatively be welded firmly to the fastening element 9. If the spring strut is pushed upwards, the anchoring bolts 12 can be inserted in the corresponding fitting holes in the cab bracket 11, followed by applying a locknut 13 to secure the bushing to the cab.

The fastening element 9 is provided, along its radially inner portion 9', with a collar which is developed upwards in the longitudinal direction of the spring strut and which has a radially inward surface substantially concentric with, and with the same top angle as, the outer surface 63 of the supporting sleeve, whereby the inner collar portion of the cab bracket is totally enclosed in the rubber bushing and is arranged at a substantially constant distance C in the circumferential direction from the outer surface 63 of the supporting sleeve.

For the sake of favourable loading of the rubber element 40, not only the supporting sleeve 6 but also the rubber element 40 and the inward-facing surface 9' of the collar are concentric and conical, with an outside diameter decreasing upwards. This results in both compressive and shear loading of the rubber element 40, which is advantageously firmly vulcanised along its radially inner surface 43 to the radially outer surface 63 of the supporting sleeve. The axial length of the rubber element at its connection to the supporting sleeve 6 may correspond to the length of the latter, in which case the upper and lower ends of the rubber element are of very limited radial extent beyond a short axial length, a fact which does not substantially affect the characteristics of the rubber bushing. The local axial length increase alongside the whole contact surface with the supporting sleeve 6 is designed to reduce the load in the jointing surfaces 43 and 63.

The rubber portions radially outwards about the collar 9' have no springing or damping function and can therefore theoretically be excluded, but from the manufacturing and strength points of view it is advantageous to cast the whole collar into the rubber element. The collar

may also be replaced by a solid fastening element with the same height as the collar, but the result would probably be an expensive and heavy structure.

Figure 3 shows the bushing 4 as initially manufactured before being fitted to the spring strut and before the stop surfaces 5,14 at the respective ends of the supporting sleeve can limit the movement of the rubber bushing. In this state the rubber bushing is not loaded by the dead weight of the cab, which means that the upper outer periphery 44 of the rubber element will be at the distance b above a plane which is tangential to the upper end surface 61 of the supporting sleeve.

After the cab has been mounted on the frame, the rubber bushing 4 is loaded by the weight of the cab so that the upper outer periphery 44 of the rubber element will be in a plane which is at the distance a_1 below a plane which is tangential to the upper end surface 61 of the supporting sleeve, as shown in Figure 1. The supporting sleeve 6 has an axial length S_L and the rubber element 40 has an axial length B_L beyond the main part of the radial extent of the rubber bushing, i.e. from a short distance from the supporting sleeve to the outer periphery of the rubber bushing. The length S_L of the supporting sleeve exceeds the length B_L of the rubber bushing so that there is a clear distance a_1 between the washer 5 and the axially directed upper surface 41 of the rubber bushing. It is advantageous that the rubber bushing be dimensioned so that the clear distance a_1 during static loading by the cab corresponds to S_L-$B_L/2$, thereby also creating a clear distance a_2 between the upper end cover 14 and the axially directed lower surface 42 of the rubber bushing. If the rubber bushing is dimensioned as above, then $a_2 = S_L - B_L/2 = a_1$ when the cab is mounted on the spring struts and statically loads the bushings.

The stop surfaces 5,14 have an outside diameter which corresponds to or slightly exceeds that of the rubber element. This results in the axially directed surfaces 41,42 of the rubber element abutting fully against the stop surfaces when the bushing "bottoms", i.e. when the spring strut is subjected to vibrations with larger amplitudes than a_1 and a_2 respectively.

Figure 4 is a schematic depiction of a cab which is flexibly suspended on four spring struts 1a-1d with respect to the vehicle frame 21. Each spring strut is in principle arranged vertically and placed in the vicinity of a corner of the cab in such a way that each spring strut absorbs a similar load. The four spring struts 1a-1d are arranged in pairs at the forward and rear edges respectively of the cab and in such a way that each spring strut in the respective pairs is

arranged at substantially the same distance D from the vehicle centreline C_L and that each spring strut in the static state does in principle absorb about 25% of the service weight of the cab 20. Each of the spring struts 1a-1d, including their bushings 4a-4d, has to be adapted to the service weight of the cab so that there is prestressing of the rubber bushing and that there are in principle equal distances a_1, a_2 between the stop surfaces 5,14 and the axially directed surfaces of the rubber bushing.

The rubber bushing is dimensioned so as to achieve a spring characteristic according to Figure 2, in which the load F is depicted as a function of the deflection movement S. In the neutral position S=0 the rubber bushing is prestressed by a static load which depends on the weight of the cab and which in this case with four evenly loaded spring struts may correspond to 25% of a normal cab weight of about 1200 kg, corresponding in the diagram to 290 kg or a load of 2900 N. This static prestressing by the weight of the cab and the clear distances a_1, a_2 of 2 mm each between the stop surfaces 5,14 and the axial surfaces 41,42 of the bushing result in a weak bushing at vibration amplitudes of up to 2 mm from a static equilibrium position. At vibration amplitudes exceeding 2 mm, the end surfaces of the rubber element "bottom" against the stop surfaces 5,14, which means that the bushing is only subjected to compressive forces and therefore becomes significantly more rigid. The rubber bushing is dimensioned so that the spring constant in the amplitude range of -2 to +2 mm from the equilibrium position is within the range 600-800 N/mm and at greater amplitudes (after the rubber element has "bottomed") it is about 4000 N/mm. For certain vehicles, spring constants of about 3000 N/mm have proved advantageous. The ratio between the spring constants should be at least 1/4.

At greater amplitudes the cab may continue to move relative to the frame. After the bushing 4 has "bottomed", the movement is essentially absorbed by the shock absorber 3 (assuming that the frequency is low enough for the shock absorber to keep up with). This happens, for example, when the vehicle is driven through a pothole or crosses any similar unevenness of the carriageway. It is advantageous that the rubber bushing be dimensioned with respect to a calculated cab service weight, which includes normal equipment in the cab and a driver. With clear distances a_1, a_2 of 2 mm in the static equilibrium position, the bushing "bottoms" at a load of 1300 N (130 kg) per spring strut. If the clear distances a_1, a_2 are increased to 3 mm each, "bottoming" only takes place at a load of 2000 N per spring strut.

Suitable dimensioning of the bushing and adaptation of the clear distances a_1,a_2 provide a

good safety margin against "bottoming" of the bushing due to static load under normal cab weight load. In the case of a higher cab service weight due, for example, to extra equipment such as coolers etc., it is easy to adapt the bushing to the higher service weight by fitting a spacing washer between the upper end cover 14 and the lower surface 62 of the supporting sleeve, provided that the outside diameter of the spacing washer corresponds to the outside diameter of this lower surface 62 of the supporting sleeve. If it is at the same time desired that the bushing should maintain a similar characteristic even when the cab moves away from the upper portion of the spring strut, the washer 5 may be replaced by a washer which is provided with an increased thickness radially outwardly about the contact surface of the washer with the upper surface 61 of the supporting sleeve. The spacing washer and the modified washer 5 are dimensioned so that the distances a_1 and a_2 are within the range 2-3 mm, and are preferably equal, when the only static load on the bushing is the cab service weight.

The embodiment described may be modified in a multiplicity of ways within the scope of the patent claims. What is essential is that the rubber bushing is capable of filtering out vibrations within the amplitude range 2-3 mm, which means that the clear distances a_1 and a_2 have to be within a corresponding range, advantageously 2.5 mm each. At the same time, the spring constant of the rubber bushing has to be adapted to any normally occurring weight increase in the cab, which weight increase must not cause the rubber bushing to "bottom" umder the static load arising from such increased weight.

The contact surfaces 9',43,63 may also be cylindrical, but this is not preferable, since the bushing would then be weaker from the purely strength point of view and would risk being sheared off.

The outer periphery of the fastening element may also be adapted to the number of bracket elements 12,13 so that the outer periphery may for example be given a triangular shape if three bracket elements 12,13 are used and are arranged at the corners of the fastening element. However, the portions of the fastening element which are enclosed in the rubber bushing and are situated radially inside would have to be given a circular shape to achieve favourable loading of the rubber bushing 4.

Patent claims.

1. Arrangement for resilient suspension of a cab (20) to a vehicle frame (21) whereby the cab is connected to the vehicle frame via a multiplicity of telescopic elements (1a-1d) which are in principle arranged vertically, whereby the lower portion (10a-10d) of each telescopic element is connected to the vehicle frame, the upper portion (4a-4d) of each spring strut is connected to the cab and each spring strut incorporates a spring (2) and a shock absorber (3) connected in parallel with the spring, and each spring strut is connected via a bushing (4) to an element (11) which is fastened to the cab, *characterised in* that the bushing incorporates a rubber element (40) arranged externally about and firmly connected to a supporting sleeve (6) which itself is firmly arranged with respect to the spring strut, which supporting sleeve (6) is provided with a surface (63) directed radially outwards against which the rubber element (40) is fixed, a fastening element (9) arranged concentrically externally about the supporting sleeve (6), which fastening element is provided with a radially inner surface (9') substantially concentric with an outer surface (63) belonging to the supporting sleeve, whereby the inner surface (9') of the fastening element is firmly arranged in the rubber bushing and is situated at a substantially constant distance (C) from the outer surface of the supporting sleeve, which fastening element (9) is provided with anchoring devices (12,13,16) situated radially outside the rubber element (40) for anchoring to the element (11) fastened to the cab, that the supporting sleeve has an axial length (S_L) and the rubber element has an axial length (B_L) along the main part of its radial extent, whereby (S_L) is larger than (B_L) so that there is a clear distance (a_1) between the axially directed upper surface (41) of the rubber element and a first stop surface (5) which for movement purposes is locked relative to the upper portion (14) of the spring strut, and that there is a clear distance (a_2) between the axially directed lower surface (42) of the rubber element and a second stop surface (14) which for movement purposes is locked relative to the upper portion of the spring strut, when the cab is fitted to the frame and statically loads the bushing.

2. Arrangement according to claim 1, *characterised in* that the outer surface (63) of the supporting sleeve is conical with diameter decreasing vertically upwards, that the fastening element (9) incorporates a developed conical collar which forms the radially inner surface (9') which is substantially concentric with the outer surface (63) of the supporting sleeve, and that the collar and the surface (9') are entirely enclosed in the rubber element (40).

3. Arrangement according to claim 1 or 2, *characterised in* that the bushing (4) is dimensioned so that the clear distances (a_1,a_2) are equal and are within the range 2-3 mm when the cab is mounted on the frame and statically loads the bushing.

4. Arrangement according to any one of claims 1-3, *characterised in* that relative movement between the cab (20) and the vehicle frame (21) with an amplitude exceeding S_L-$B_L/2$ in the direction of the spring strut is absorbed in the bushing (4) so that the axially directed surfaces (41,42) of the rubber element come to abut against the stop surfaces (5,14).

5. Arrangement according to any one of claims 1-4, *characterised in* that the rubber bushing is dimensioned so that its spring constant increases by at least five times when the axially directed surfaces (41,42) of the rubber bushing come to abut against the stop surfaces (5,14), i.e. on the occasion of larger relative movements between the cab (20) and the upper portion (14) of the spring strut than a_1 and a_2 respectively.

6. Arrangement according to any one of claims 1-5, *characterised in* that the spring constant of the rubber bushing is of the order of 600-800 N/mm on the occasion of a relative movement of less than a_1 or a_2 respectively between the cab (20) and the upper portion (14) of the spring strut, and that the spring constant of the rubber bushing is about 3000 N/mm on the occasion of a relative movement exceeding a_1 and a_2 respectively between the cab (20) and the upper portion (14) of the spring strut.

7. Arrangement according to any one of claims 1-6, *characterised in* that the spring (2) is an air bellows which surrounds the shock absorber (3), that the air bellows (2) and the shock absorber (3) are clamped between upper and lower end covers (14,15) integrated into the spring strut, and that the element (11) fastened to the cab consists of a solid cast element fixed to the firewall of the cab.

8. Bushing (4) intended for supporting a spring strut of a heavy-duty vehicle with respect to the latter's cab, *characterised by* a supporting sleeve (6) with shell surface (63) directed outwards, by a surface (63) surrounding and at the same time firmly connected to a rubber element (40), which rubber element has an axial length which is essentially shorter than the axial length of the supporting sleeve, and by a fastening element (9) arranged concentrically externally about the supporting sleeve (6), which fastening element has at its radially inner portion a developed collar with a radially inner surface (9') which is substantially concentric with and at a constant distance (C) from the aforesaid surface (63), and has at its radially outer portion at least one anchoring device (16), whereby the supporting sleeve (6) is arranged to be secured to the spring strut and the anchoring device is arranged to be secured to the cab.

9. Bushing (4) according to claim 8, *characterised in* that the outer surface (63) of the supporting sleeve is conical with diameter decreasing vertically upwards, that the inner surface (9') is substantially concentric with the shell surface (63) of the supporting sleeve, and that the collar and the inner surface (9') are entirely enclosed in the rubber element (40).

10. Bushing (4) according to claim 8 or 9, *characterised in* that the supporting sleeve (6) has running axially through it a central hole intended to accommodate a rod-shaped fastening device, and that the radially outer portion of the fastening element is disc-shaped with its normal direction substantially parallel with the axial centreline of the aforesaid central hole.

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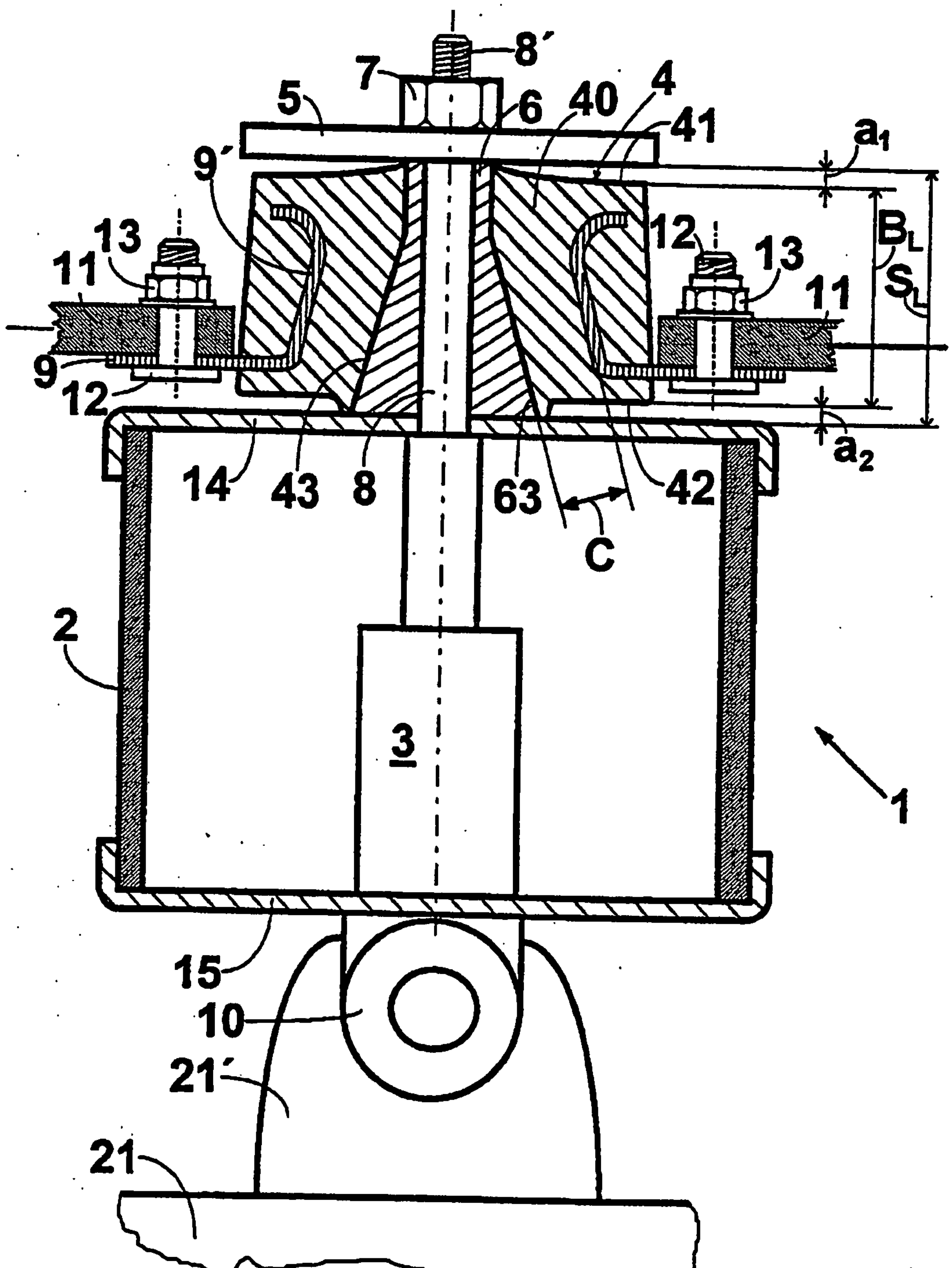
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Fig. 1

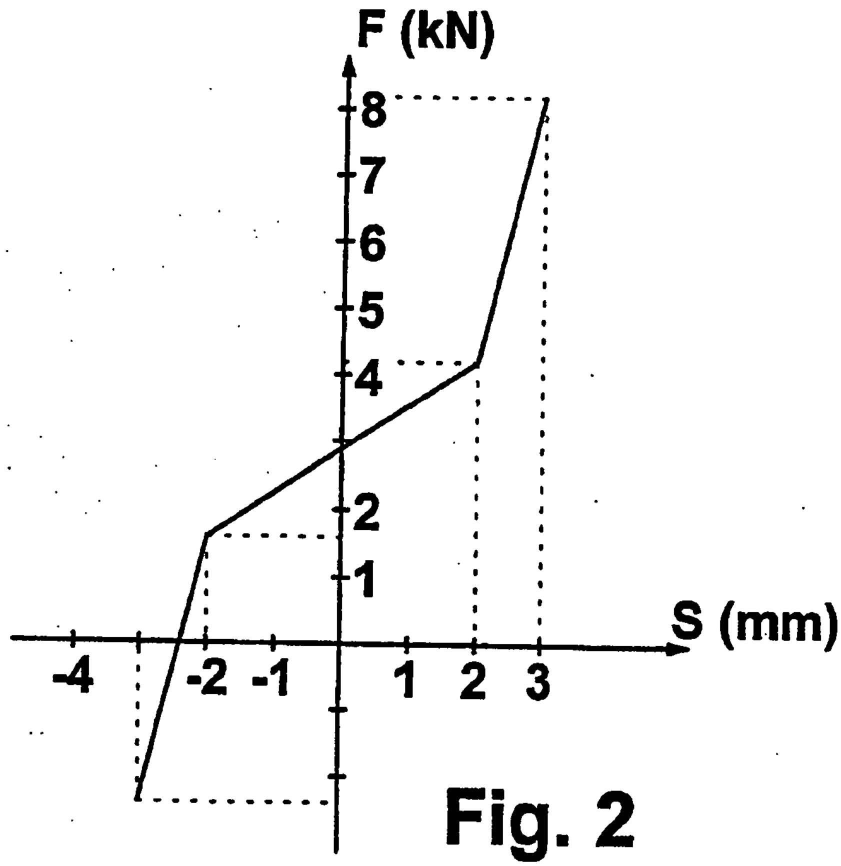

Fig. 2

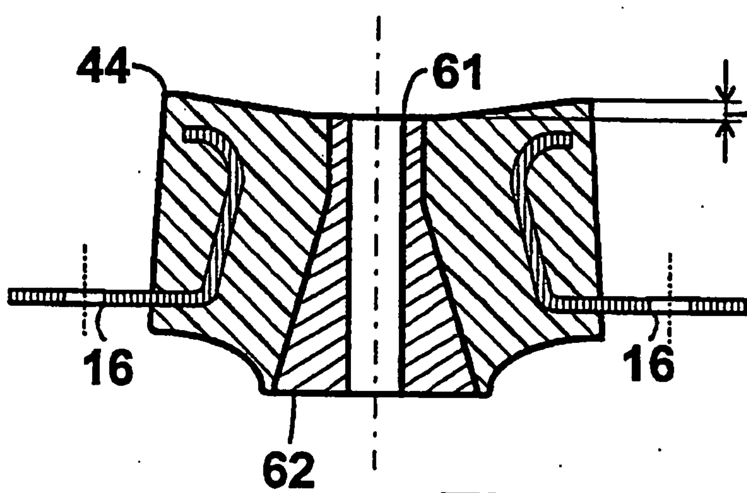

Fig. 3

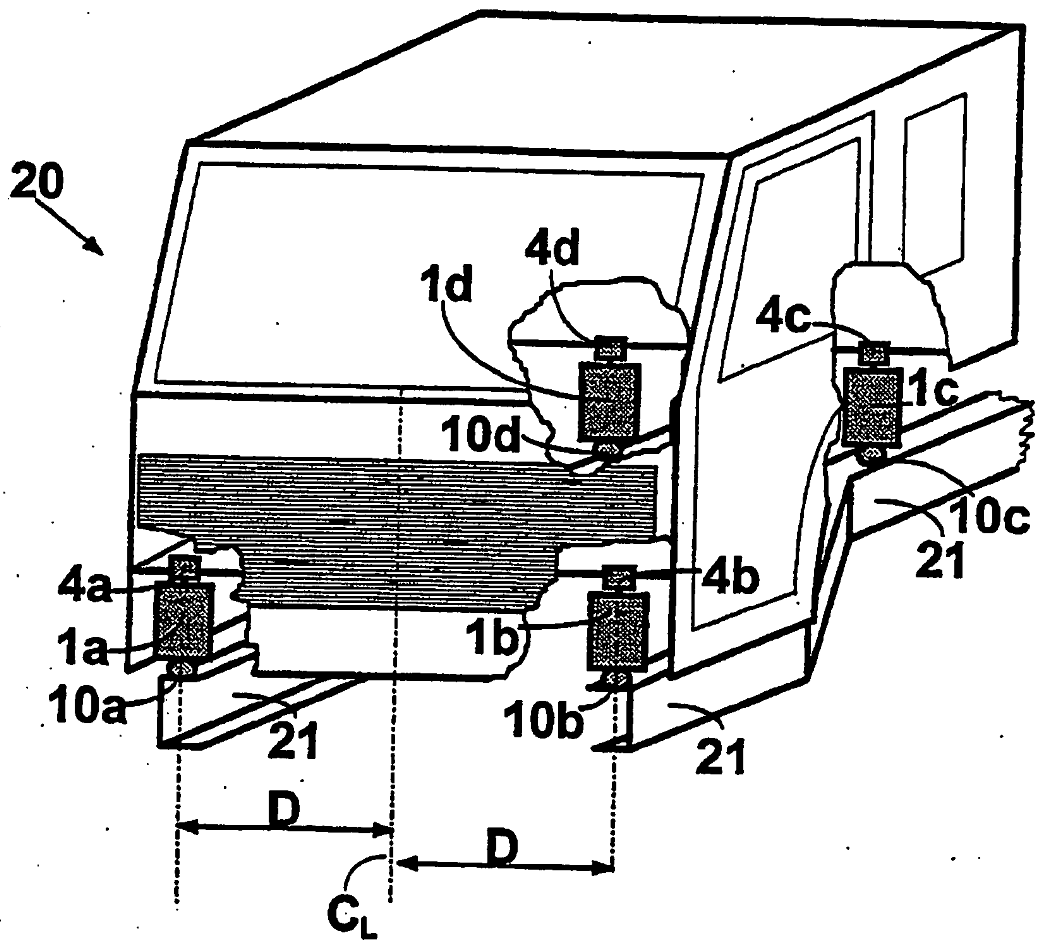

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01025

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B62D 33/10
According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 2148126 A (KLÖCKNER-HUMBOLDT-DEUTZ AG), 5 April 1973 (05.04.73) --	1-10
A	Patent Abstracts of Japan, Vol 11,No 76, M-569, abstract of JP,A,61-232968 (Nissan Motor Co Ltd), 17 October 1986 (17.10.86) --	1-10
A	EP 0429084 A1 (KLÖCKNER-HUMBOLDT-DEUTZ), 29 May 1991 (29.05.91) --	1-10
A	WO 9319973 A1 (AB VOLVO), 14 October 1993 (14.10.93) -- -------	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
3 December 1996	04 -12- 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Hans Nordström Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/10/96

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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